Rescue and Fire Fighting Service (RFFS)

Foam and the Environment

Information Paper

IP-6

Information for purchasers of fire fighting foam on the effects on the environment

Issue 1, October 2008

Preface

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Enquiries regarding the content of this publication should be addressed to:
Aerodrome Standards Department, Safety Regulation Group, Civil Aviation Authority, Aviation House, Gatwick Airport South, West Sussex, RH6 0YR.

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1 Introduction

The information in this paper has been prepared in consultation with the UK environmental agencies. Its purpose is to enable purchasers of fire fighting foam to ask potential suppliers for consistent and comparable information on the effects of their product on the environment. The purchaser can then add this information to the other considerations in procuring the foam.

Environmental problems with foams can be categorised under four basic headings: biodegradation; acute and chronic toxicity; persistence (especially of fluorosurfactants) and; bio-accumulation potential.

2 Information

The primary source of information, in so far as it is readily and publicly available, is to be found in the Safety Data Sheets[1] (SDS) for each product. In practice the information in these sheets can be very variable. The data from one manufacturer's SDS is rarely directly comparable with that from another; different units will be quoted or different test species used for toxicity testing.

The following paragraphs comment on the more important sections of a standard 16 section SDS, from which a potential purchaser can understand the consequences of different products on the environment and extract some requirements to be imposed on suppliers.

3 Composition (Section 2 of an SDS)

We need accurate information regarding the individual ingredients (not just a generic chemical group name e.g. "anionic surfactants") together with accurate percentage proportions rather than wide bands (e.g. “>10%” or “5 - 20%”).

This information will allow sensible enquiries to be made on the toxicity and the environmental fates of the ingredients. It is fully recognised that once ingredients are mixed together, the toxicity and environmental fate profile of the mixture may be different from any or indeed all of the individual ingredients. This is a case where no single piece of data can give all the answers for a complex mixture that a foam concentrate represents and each piece of data contributes a little bit more to the overall picture.

It is also recognised that in imparting the above information, a company will feel it is giving away its trade secrets and competitive edge. It will be for purchasers to insist on adequate and appropriate information.

4 Toxicological Information (Section 11 of an SDS)

Many foam formulators take this section as requiring only toxicity information in respect of humans or possibly some other mammal that can be made to approximate to human toxicity. In point of fact this section should contain aquatic toxicity information for other ‘environmental' species, particularly fish, invertebrates and algae.

It is imperative that toxicity testing is done on the concentrate rather than literature data being quoted for individual ingredients. It is in this and the next SDS section that any potential interactions between ingredients giving greater (or lesser) consequences for the environment are going to show themselves.

[1] Previously known as Material Safety Data Sheets (MSDS).

Where aquatic toxicity data are quoted there is almost no uniformity over the species tested. This can reflect the fact that a product is manufactured abroad and the home climate does not support UK indigenous species. Where there is the opportunity to specify the test species, then sensible choices would be rainbow trout (pollution intolerant game fish), the common minnow (a more pollution tolerant course fish species) and the water flea (*daphnia magna*) as the invertebrate. The ultimate choice of test animal has as much to do with its ready availability and the reproducibility of results as it has to do with its frequency of observation in the local natural environment.

Test durations of greater than 96 hours are never seen. The results quoted are therefore always only ever short-term, acute toxicity levels. This may be valid for even slow flowing river situations following product spills, but does not help in considering the impacts of permanent (ongoing) discharges containing foam run-off.

For toxicity results, high figures are better since it means more of the product is required to kill off 50% of the test animals. LC_{50} means Lethal Concentration for a 50% kill rate.

The bioaccumulation potential of individual ingredients (most notably the fluorosurfactants) may or may not be known in detail but where data is available it certainly should be quoted.

5 Ecological Information (Section 12 of an SDS)

In this section we are used to seeing figures quoted for Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD). The figures quoted in this section must be for the concentrate since strictly the whole document relates to the product as sold, and indeed used by the purchaser, rather than the diluted product at the time of use.

The COD test is carried out in a laboratory using very aggressive oxidising conditions to give in effect a maximum figure for the degree of oxidation the test material could undergo. This degree of oxidation will never be achieved in the natural environment.

The BOD test by comparison approximates to the natural environment conditions. These tests are also carried out in the laboratory but utilise natural (sewage effluent type) bacteria to do the oxidising. Samples are incubated at 20^{o}c for various time periods. Whilst the use of 20^{o}c is somewhat artificial for water temperatures in the UK, it does increase the reproducibility of the test. As the BOD test is empirical (as it uses living bacteria), repetitions of the test even for the same test duration will not give identical results. The COD test on the other hand should give very similar results if repeated.

COD figures are absolute and there should only be one. By comparison several BOD figures may be quoted and together these are extremely useful in building up a picture of the overall natural degradability of the concentrate in the environment. The most common period for the BOD test is five days and this is quoted by a suffix figure five being shown after the initials BOD, as in BOD_5. The BODs should be done for a range of other time periods e.g. 10, 15, 21/28 (max) days. The exact number of days are not too critical provided there are several data points giving the opportunity for a picture of the progressive natural degradation of the product to be built up. A graph can be constructed showing the BOD figures against time and comparison of this curve with the COD figure gives a good indication of how the product is going to be degraded in the aquatic environment over time.

UK practice is to quote BOD figures over discrete periods of time e.g. 5 or 10 days as discussed above. Another valid but less common approach (at least in UK) is to quote percentage degradations without an actual figure of x mg/l. The tests giving percentage results use respirometry where carbon dioxide production by bacteria is recorded rather than oxygen consumption as in BOD_5 or BOD_{10} 'closed bottle' tests. Graphing these results is still possible if the COD is taken as 100%.

Low COD and low BOD figures are always preferable as this means a lower de-oxygenation potential in any receiving water body. High COD and low BOD figures pose the question of what in the product is not being broken down by the bacteria. A BOD/COD ratio may be quoted. If this is approaching unity it would represent a material that was fully biodegradable in the natural environment.

It would be preferable for data to be presented on the effects of the concentrate on sewage treatment processes. There are recognized experimental procedures for achieving these. The figures obtained give useful information about the concentrations of foam that could be successfully treated without adverse effect in a municipal treatment works. This helps with decisions around the possible options for treatment of training ground run-off. Whether this information is declared here in Section 12 or in Section 11 of the MSDS matters little.

6 Further Reading

- Fire and Rescue Manual, Volume 2 – Fire Service Operations, Environmental Protection. ISBN 10 0113413165
- OECD - Guideline for testing of chemicals – Ready Biodegradability (Fully describes the various standard OECD test methods for assessing biodegradability i.e. BOD)